EXHIBIT Q

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15/050,673	02/23/2016	Avi Kopelman	22773-822.301	2186

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WSGR / Align Technology , Inc.
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EXAMINER	
MAPAR, BIJAN	
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2128	
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patentdocket@wsgr.com

Office Action Summary	**Application No.** 15/050,673	**Applicant(s)** Kopelman, Avi	
	Examiner BIJAN MAPAR	**Art Unit** 2128	**AIA (FITF) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
  Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 4/15/2019.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1,4-11 and 14-26 is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.
6) ☐ Claim(s) _____ is/are allowed.
7) ☑ Claim(s) 1,4-11 and 14-26 is/are rejected.
8) ☐ Claim(s) _____ is/are objected to.
9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.
11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a)☐ All b)☐ Some** c)☐ None of the:
1.☐ Certified copies of the priority documents have been received.
2.☐ Certified copies of the priority documents have been received in Application No. _____.
3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date 4/24/2019.
3) ☑ Interview Summary (PTO-413)
Paper No(s)/Mail Date 7/22/2019.
4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 4/24/2019 has been entered.

Claims 1, 4-11, and 14-26 are pending. Claims 1, 7-11, and 17-24 are amended. Claims 25 and 26 are newly added.

Response to Arguments

Applicant's amendments have overcome the previous 35 USC 112(b) rejections, which are withdrawn.

Under the 2019 PEG, the claims are eligible under 35 USC 101. The claims are not directed to a judicial exception under that guidance. Further, the claims provide a clear practical application of providing more precise dental visualizations of a patient to a dental practitioner (see for example ¶3-4 of the instant application's specification).

As noted in the interview, the amendments have overcome the 35 USC 102 rejections over Rubbert. New grounds of rejection, incorporating the Paley (US 2007/0172112 A1) and Kriveshko (US 2007/0236494 A1) references, are presented below. These references were cited by applicant on the IDS dated 4/24/2019 as citation numbers 5 and 6 respectively.

The non-statutory double patenting rejection remains applicable, and is presented below with updated language to match the amendments.

Several minor typographical issues are present within the amendments and are objected to (see section below).

Claim Objections

Claims 7 and 10 are objected to because of the following informalities:

Claim 7 recites "The method according to claim 6, wherein receiving the identification of the portion of the first virtual model that is a deficient representation of the first physical portion of the teeth **further comprising** a step of". The verb tense should be changed in the emphasized section to read "further comprises" rather than comprising.

Claim 7 further recites "wherein the first display image portion includes the portion of the first virtual model that is the deficient **representation the** first physical portion of the teeth, and". The emphasized text appears to be missing the word "of", and should almost certainly read "representation of the".

Claim 10 recites "wherein the second physical portion **of the second physical part** corresponds to the first physical portion **of the first physical part** wherein the at least the part of the surface of the first physical portion is now unobscured by soft tissue or materials.". The emphasized regions should be deleted to conform with the other editing made to the claims, and are being interpreted to be deleted for the purpose of examination (otherwise an antecedent basis issue under 35 USC 112(b) would be caused). It seems probable that a typographic oversight was made that did not delete these. The term "part of the surface" should remain in the claim, but the term "physical part" should be deleted throughout claim 10, as it was deleted earlier in the claim (and in all other claims).

Appropriate correction is required.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal

Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

Claims 1, 4-11, and 14--22 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 2-5, 12-13, 23-27, and 29 of U.S. Patent No. 9,299,192. Although the claims at issue are not identical, they are not patentably distinct from each other because of the following mappings:

Claim 1 of the instant application is equivalent to claim 2 of the reference application, with the limitations of claim 29 appended as noted below in the table:

Claim 1, instant application	**Claim 2 (including the limitations of claim 1), reference application**
A method for generating a modified virtual model of a physical structure, comprising:	A method for generating a modified virtual model of a physical structure, comprising:
displaying, on a display operatively connected to a computer system, an image of a first virtual model	(A) displaying an image of a first virtual model on a display operatively connected to a computer system,
teeth	(claim 2) a physical dental model representative of said intra-oral cavity
wherein the first virtual model is generated from first 3D intraoral scan data of the teeth, and	wherein the first virtual model is generated from first 3D scan data of the physical structure, and

wherein the first virtual model includes a portion that is a deficient representation of a first physical portion of the teeth;	wherein said first virtual model fails to properly represent a first physical part of the physical structure;
receiving an identification of the portion of the first virtual model that is the deficient representation of the first physical portion of the teeth;	receiving user input identifying at least a portion of the first virtual model that is desired to be modified, wherein the user input is generated by user interaction with the image on the display;
obtaining, by an intraoral scanner, a second virtual model of the teeth with the computer system,	(C) receiving a second virtual model of the physical structure with the computer system,
the second virtual model generated from second 3D intraoral scan data of the teeth; and	the second virtual model generated from second 3D scan data of the physical structure; and
modifying, by the computer system, the first virtual model with the computer system by replacing at least the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth with a corresponding portion of the second virtual model that provides an adequate representation of the first physical portion,	D) modifying the first virtual model with the computer system by replacing at least said identified portion of the first virtual model with a corresponding portion of the second virtual model,
thereby generating the modified virtual model; and	thereby generating the modified virtual model.

wherein the at least the identified portion of the first virtual model is of the first physical portion of the teeth, and the corresponding portion of the second virtual model is also of the first physical portion of the teeth;	It would have been obvious to one having ordinary skill in the art at the time the invention was filed to apply the details of claim 29 of the reference application to claim 2 of the reference application, in order to provide functionality that enhances model accuracy for a given model region, thereby improving the model. (claim 29) The system according to claim 28, wherein the at least said identified portion of the first virtual model and the corresponding portion of the second virtual model are each representative of a physical portion of the physical structure,

Claim 11 of the instant application is equivalent to claim 29 of the reference application, with the limitations of claim 29 appended as noted below in the table:

Claim 11, instant application	**Claim 29 (including the limitations of claim 28), reference application**
A system to generate a modified virtual model of a patient's teeth, comprising:	A system to generate a modified virtual model of a physical structure, comprising:
a display to display images of the modified virtual model; and	a display to display images of said modified virtual model; and

teeth	It would have been obvious to one having ordinary skill in the art at the time the invention was filed to apply the details of claim 2 of the reference application to claim 29 of the reference application, in order to provide a useful application for the system, improving its industrial applicability. (claim 2) a physical dental model representative of said intra-oral cavity
a computer system operatively connected to the display and comprising a program that, when executed by the computer system, causes the computer system to:	a computer system operatively connected to the display and comprising a program that, when executed by the computer system, causes the computer system to,
display an image of a first virtual model on the display,	display an image of a first virtual model
wherein the first virtual model is generated from first 3D scan data of the teeth, and	a first virtual model generated from first 3D scan data of the physical structure on the display,
wherein the first virtual model includes a portion that is a deficient representation of a first physical portion of the teeth;	wherein said first virtual model fails to properly represent a first physical part of the physical structure,
receive an identification of the portion of the first virtual model that is the deficient representation of the first physical portion of the teeth;	receive user input identifying at least a portion of the first virtual model that is desired to be modified,

obtain a second virtual model of the teeth with the computer system,	receive a second virtual model of the physical structure,
the second virtual model generated from second 3D scan data of the teeth; and	the second virtual model generated from second 3D scan data of the physical structure, and
modify the first virtual model with the computer system by replacing at least the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth with a corresponding portion of the second virtual model that provides an adequate representation of the first physical portion,	modify the first virtual model by replacing at least said identified portion of the first virtual model with a corresponding portion of the second virtual model,
thereby generating the modified virtual model; and	thereby providing the modified virtual model.
wherein the at least the identified portion of the first virtual model is of the first physical portion of the teeth, and the corresponding portion of the second virtual model is also of the first physical portion of the teeth;	(claim 29) The system according to claim 28, wherein the at least said identified portion of the first virtual model and the corresponding portion of the second virtual model are each representative of a physical portion of the physical structure,

Claim 21, instant application	**Claim 29 (including the limitations of claim 28), reference application**
A system to generate a modified virtual model of a patient's teeth, comprising:	A system to generate a modified virtual model of a physical structure, comprising:

an intraoral scanner; and	(claim 2) wherein said physical structure comprises any one of an intra-oral cavity of a patient or a physical dental model representative of said intra-oral cavity.
a non-transitory computer readable medium including instructions that when executed by a computer system, causes the computer system to:	a computer system operatively connected to the display and comprising a program that, when executed by the computer system, causes the computer system to,
display an image of a first virtual model on a display,	a display to display images of said modified virtual model; and
teeth	(claim 2) a physical dental model representative of said intra-oral cavity
wherein the first virtual model is generated from first 3D scan data of the teeth, and	display an image of a first virtual model
wherein the first virtual model includes a portion that is a deficient representation of a first physical portion of the teeth;	wherein said first virtual model fails to properly represent a first physical part of the physical structure,
receive an identification of the portion of the first virtual model that is the deficient representation of the first physical portion of the teeth;	receive user input identifying at least a portion of the first virtual model that is desired to be modified,
obtain a second virtual model of the teeth with the computer system,	receive a second virtual model of the physical structure,

the second virtual model generated from second 3D scan data of the teeth; and	the second virtual model generated from second 3D scan data of the physical structure, and
modify the first virtual model with the computer system by replacing at least the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth with a corresponding portion of the second virtual model that provides an adequate representation of the first physical portion,	modify the first virtual model by replacing at least said identified portion of the first virtual model with a corresponding portion of the second virtual model,
thereby generating the modified virtual model; and	thereby providing the modified virtual model.
wherein the portion of the first virtual model is of the first physical portion of the teeth, and the corresponding portion of the second virtual model is also of the first physical portion of the teeth.	It would have been obvious to one having ordinary skill in the art at the time the invention was filed to apply the details of claim 29 of the reference application to claim 2 of the reference application, in order to provide functionality that enhances model accuracy for a given model region, thereby improving the model. (claim 29) The system according to claim 28, wherein the at least said identified portion of the first virtual model and the corresponding portion of the second virtual model are each representative of a physical portion of the physical structure,

Dependent claims 4 and 14 correspond to claim 23 and 25-27 of the reference.

Dependent claims 5 and 15 correspond to claim 24 of the reference.

Dependent claims 6 and 16 correspond to claim 3 of the reference.

Dependent claims 7, 17, and 22 correspond to claim 4 of the reference.

Dependent claims 8 and 18 correspond to claim 5 of the reference.

Dependent claims 9 and 19 correspond to claim 12 (including the limitations of 11 by virtue of the dependence of reference claim 12 on 11) of the reference.

Dependent claims 10 and 20 correspond to claim 13 of the reference.

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

Claims 1, 4-11, 14-22, and 24-26 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over **Rubbert** (US 2002/0006217A1) in view of **Paley** (US 2007/0172112 A1, cited by

applicant on the IDS dated 4/24/2019) and **Kriveshko** (US 2007/0236494 A1, cited by applicant on the IDS dated 4/24/2019).

Regarding Claim 1:

Rubbert teaches:

"displaying, on a display operatively connected to a computer system, an image of a first virtual model (¶128 The scanning work station 16 also includes the monitor 20 for displaying the scanning results as a three-dimensional model 18 of the dentition in real time as the scanning is occurring; ¶226 The frames are obtained at a rate of at least one frame per second as the scanner is moved over the teeth. The scanning of an entire jaw may require three separate scanning operations or “segments” due to maneuverability constraints and a break in the capturing of images. While the scanning is occurring, the four steps of FIG. 6 are performed for the stream of captured images; examiner notes that this illustrates that the mdoel is updated as the scanning occurs, and that it is displayed in real time showing the updates.

¶229 The result, step 86 of FIG. 6, is a set of three dimensional coordinates for all the points in the image, a point cloud comprising a “frame.” FIG. 29 is an illustration of a single “frame” of data, that is, a three-dimensional point cloud of a scanned object which has been calculated from a single two dimensional image by the pattern recognition, decoding, and 3-D calculations described herein; ¶230 Commercially available off-the-shelf software exists for taking a set of three dimensional coordinates and displaying them on a computer monitor, and such software is used to display the three dimensional surfaces; examiner notes that this illustrates the frames themselves (which fall within the term models) are also displayed.)"

wherein the first virtual model is generated from first 3D intraoral scan data of the teeth, and (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a

step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that as described, the frames would fall within the broadest reasonable interpretation of models; ¶131 The tip 68 is sized and shaped such that it can be inserted into and moved within an oral cavity of a human so as to enable scanning of anatomical structures inside the oral cavity; ¶226 A complete three-dimensional model of the patient's dentition can be generated from the scanning system of the present invention.)

wherein the first virtual model includes a portion that is a deficient representation of a first physical portion of the teeth; (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of

the surface of the the object; examiner notes that substantial overlap is present, but that the at least two frames of the reference are each incomplete regarding the object being modelled, thereby each failing to represent some part of the object)

thereby generating the modified virtual model; and (¶24; ¶28 processing said data representing the set of frames with the data processing system so as to register the frames relative to each other to thereby produce a three-dimensional virtual representation of the portion of the surface of the object covered by the set of frames ... the three-dimensional virtual representation being substantially consistent with all of the frames.)

wherein the at least the identified portion of the first virtual model is of the first physical portion of the teeth, and the corresponding portion of the second virtual model is also of the first physical portion of the teeth; (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that as described, the frames would fall within the broadest reasonable interpretation of models.)

Rubbert does not teach in particular:

receiving an identification of the portion of the first virtual model that is the deficient representation of the first physical portion of the teeth;

obtaining, by an intraoral scanner, a second virtual model of the teeth with the computer system,

the second virtual model generated from second 3D intraoral scan data of the teeth; and

modifying, by the computer system, the first virtual model with the computer system by replacing at least the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth with a corresponding portion of the second virtual model that provides an adequate representation of the first physical portion,

Paley teaches:

receiving an identification of the portion of the first virtual model that is the deficient representation of the first physical portion of the teeth; (¶60 One user control (not shown) may permit a user to return to data acquisition, e.g., the scanning mode of FIG. 4, to acquire additional data where a void or deviation is detected (either automatically or through human visual inspection). This control, or another control, may permit a user to select a specific point on the surface of the digital model (or the scan subject, although the distinction becomes trivial for highly detailed and accurate digital models) where the continuous scan is to be reacquired from the subject)

obtaining, by an intraoral scanner, a second virtual model of the teeth with the computer system, (¶38 In a related landing mode, a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model. Similar visual feedback tools may be provided to guide a user to an appropriate scan location, and notify a user when the scan has been reacquired; ¶60 may permit a user to select a specific point on the surface of the digital model (or the scan subject, although the distinction becomes trivial for highly detailed and accurate digital models) where the continuous scan is to be reacquired from the subject)

the second virtual model generated from second 3D intraoral scan data of the teeth; and (¶28 the system 100 may include a scanner 102 that captures images of a subject 104 within an image plane 106, and forwards the images to a computer 108, which may include a display 110)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the dental modeling features features of Paley in the modeling and imaging system of Rubbert, in order to provide improved guidance and visual feedback systems for use with particular three-dimensional imaging applications, such as digital dentistry (Paley, ¶9)

Kriveshko teaches:

modifying, by the computer system, the first virtual model with the computer system by replacing at least the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth with a corresponding portion of the second virtual model that provides an adequate representation of the first physical portion, (¶59 a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model; ¶70 any suitable technique for registering new three-dimensional data to existing three-dimensional data may be usefully employed in step 216; ¶74 all of the three-dimensional data acquired during the recover mode may be immediately registered to the original three-dimensional model; ¶83-85; ¶86 When a successful test fit is made to the original (acquisition mode) three-dimensional model, the entire new three-dimensional model, or a selected portion thereof, may be registered to the original three-dimensional model using a transformation based upon the successfully fitted frames or three-dimensional images; see also ¶28, 298, 299, and 300 of Rubbert)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the landing mode of Kriveshko when implementing the system of Rubbert as modified by Paley, because Paley explicitly discloses a landing mode, and notes that the landing mode disclosed in Kriveshko is how this should be implemented (Paley, ¶60).

Regarding Claim 11:

Rubbert teaches:

a display to display images of the modified virtual model; and (¶128 The scanning work station 16 also includes the monitor 20 for displaying the scanning results as a three-dimensional model 18 of the dentition in real time as the scanning is occurring;)

a computer system operatively connected to the display and comprising a program that, when executed by the computer system, causes the computer system to: (¶101 workstation computer (either scanning station or back office server workstation))

"display an image of a first virtual model on the display, (¶128 The scanning work station 16 also includes the monitor 20 for displaying the scanning results as a three-dimensional model 18 of the dentition in real time as the scanning is occurring; ¶226 The frames are obtained at a rate of at least one frame per second as the scanner is moved over the teeth. The scanning of an entire jaw may require three separate scanning operations or "segments" due to maneuverability constraints and a break in the capturing of images. While the scanning is occurring, the four steps of FIG. 6 are performed for the stream of captured images; examiner notes that this illustrates that the mdoel is updated as the scanning occurs, and that it is displayed in real time showing the updates.

¶229 The result, step 86 of FIG. 6, is a set of three dimensional coordinates for all the points in the image, a point cloud comprising a "frame." FIG. 29 is an illustration of a single "frame" of data, that is, a three-dimensional point cloud of a scanned object which has been calculated from a single two dimensional image by the pattern recognition, decoding, and 3-D calculations described herein; ¶230 Commercially available off-the-shelf software exists for taking a set of three dimensional coordinates and displaying them on a computer monitor, and such software is used to display the three dimensional

surfaces; examiner notes that this illustrates the frames themselves (which fall within the term models) are also displayed.)"

wherein the first virtual model is generated from first 3D scan data of the teeth, and (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that as described, the frames would fall within the broadest reasonable interpretation of models.)

wherein the first virtual model includes a portion that is a deficient representation of a first physical portion of the teeth; (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the

surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that substantial overlap is present, but that the at least two frames of the reference are each incomplete regarding the object being modelled, thereby each failing to represent some part of the object)

thereby generating the modified virtual model; and (¶24; ¶28 processing said data representing the set of frames with the data processing system so as to register the frames relative to each other to thereby produce a three-dimensional virtual representation of the portion of the surface of the object covered by the set of frames ... the three-dimensional virtual representation being substantially consistent with all of the frames.)

wherein the at least the identified portion of the first virtual model is of the first physical portion of the teeth, and the corresponding portion of the second virtual model is also of the first physical portion of the teeth; (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that as described, the frames would fall within the broadest reasonable interpretation of models.)

Rubbert does not teach in particular:

receive an identification of the portion of the first virtual model that is the deficient representation of the first physical portion of the teeth;

obtain a second virtual model of the teeth with the computer system,

the second virtual model generated from second 3D scan data of the teeth; and

modify the first virtual model with the computer system by replacing at least the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth with a corresponding portion of the second virtual model that provides an adequate representation of the first physical portion,

Paley teaches:

receive an identification of the portion of the first virtual model that is the deficient representation of the first physical portion of the teeth; (¶60 One user control (not shown) may permit a user to return to data acquisition, e.g., the scanning mode of FIG. 4, to acquire additional data where a void or deviation is detected (either automatically or through human visual inspection). This control, or another control, may permit a user to select a specific point on the surface of the digital model (or the scan subject, although the distinction becomes trivial for highly detailed and accurate digital models) where the continuous scan is to be reacquired from the subject)

obtain a second virtual model of the teeth with the computer system, (¶38 In a related landing mode, a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model. Similar visual feedback tools may be provided to guide a user to an appropriate scan location, and notify a user when the scan has been reacquired; ¶60 may permit a user to select a specific point on the surface of the digital model (or the scan subject, although the distinction becomes trivial for highly detailed and accurate digital models) where the continuous scan is to be reacquired from the subject)

the second virtual model generated from second 3D scan data of the teeth; and (¶28 the system 100 may include a scanner 102 that captures images of a subject 104 within an image plane 106, and forwards the images to a computer 108, which may include a display 110)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the dental modeling features features of Paley in the modeling and imaging system of Rubbert, in order to provide improved guidance and visual feedback systems for use with particular three-dimensional imaging applications, such as digital dentistry (Paley, ¶9)

Kriveshko teaches:

modify the first virtual model with the computer system by replacing at least the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth with a corresponding portion of the second virtual model that provides an adequate representation of the first physical portion, (¶59 a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model; ¶70 any suitable technique for registering new three-dimensional data to existing three-dimensional data may be usefully employed in step 216; ¶74 all of the three-dimensional data acquired during the recover mode may be immediately registered to the original three-dimensional model; ¶83-85; ¶86 When a successful test fit is made to the original (acquisition mode) three-dimensional model, the entire new three-dimensional model, or a selected portion thereof, may be registered to the original three-dimensional model using a transformation based upon the successfully fitted frames or three-dimensional images; see also ¶28, 298, 299, and 300 of Rubbert)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the landing mode of Kriveshko when implementing the system of Rubbert as modified by Paley, because Paley explicitly discloses a landing mode, and notes that the landing mode disclosed in Kriveshko is how this should be implemented (Paley, ¶60).

Regarding Claims 4 and 14:

Rubbert teaches:

manufacturing, based on the modified virtual model, at least one a physical dental model of an intra-oral cavity, a dental aligner, an orthodontic appliance, or a dental prosthesis. (¶116 When the orthodontist has finished designing the orthodontic appliance for the patient, digital information regarding the patient, the malocclusion, and a desired treatment plan for the patient are sent over the communications medium to the appliance service center 26. A customized orthodontic archwire and a device for placement of the brackets on the teeth at the selected location is manufactured at the service center and shipped to the clinic 22; examiner notes this is disclosing an orthodontic appliance, and could be said to fall within dental aligner/dental prosthesis as well.)

Regarding Claims 5 and 15:

Rubbert teaches:

designing an orthodontic treatment plan based on the modified virtual model. (¶116 The back office server 28 executes an orthodontic treatment planning software program. The software obtains the three-dimensional digital data of the patient's teeth from the scanning node 16 and displays the model 18 for the orthodontist. The treatment planning software includes features to enable the orthodontist to manipulate the model 18 to plan treatment for the patient.)

Regarding Claims 6 and 16:

Rubbert teaches:

wherein the first virtual model includes a first 3D virtual model representative of the first physical portion of the teeth, and (¶22 During scanning, the scanner and object are moved relative to

each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that as described, the frames would fall within the broadest reasonable interpretation of models.)

"the displaying step comprises receiving the first 3D virtual model at the computer system and displaying on the display a first display image corresponding to the first 3D virtual model. (¶128 The scanning work station 16 also includes the monitor 20 for displaying the scanning results as a three-dimensional model 18 of the dentition in real time as the scanning is occurring; ¶226 The frames are obtained at a rate of at least one frame per second as the scanner is moved over the teeth. The scanning of an entire jaw may require three separate scanning operations or “segments” due to maneuverability constraints and a break in the capturing of images. While the scanning is occurring, the four steps of FIG. 6 are performed for the stream of captured images; examiner notes that this illustrates that the mdoel is updated as the scanning occurs, and that it is displayed in real time showing the updates.

¶229 The result, step 86 of FIG. 6, is a set of three dimensional coordinates for all the points in the image, a point cloud comprising a “frame.” FIG. 29 is an illustration of a single “frame” of data, that is, a three-dimensional point cloud of a scanned object which has been calculated from a single two dimensional image by the pattern recognition, decoding, and 3-D calculations described herein; ¶230

Commercially available off-the-shelf software exists for taking a set of three dimensional coordinates and displaying them on a computer monitor, and such software is used to display the three dimensional surfaces; examiner notes that this illustrates the frames themselves (which fall within the term models) are also displayed.)"

Regarding Claims 7 and 17:

Rubbert does not teach in particular:

receiving user input identifying on the first display image at least a first display image portion thereof generated by user interaction with the display,

wherein the first display image portion includes the portion of the first virtual model that is the deficient representation the first physical portion of the teeth, and

wherein the at least the physical portion of the first virtual model replaced in the modifying step corresponds to the identified at least the physical portion.

Paley teaches:

receiving user input identifying on the first display image at least a first display image portion thereof generated by user interaction with the display, (¶60 One user control (not shown) may permit a user to return to data acquisition, e.g., the scanning mode of FIG. 4, to acquire additional data where a void or deviation is detected (either automatically or through human visual inspection). This control, or another control, may permit a user to select a specific point on the surface of the digital model (or the scan subject, although the distinction becomes trivial for highly detailed and accurate digital models) where the continuous scan is to be reacquired from the subject)

wherein the first display image portion includes the portion of the first virtual model that is the deficient representation the first physical portion of the teeth, and (¶60 One user control (not shown) may permit a user to return to data acquisition, e.g., the scanning mode of FIG. 4, to acquire additional

data where a void or deviation is detected (either automatically or through human visual inspection). This control, or another control, may permit a user to select a specific point on the surface of the digital model (or the scan subject, although the distinction becomes trivial for highly detailed and accurate digital models) where the continuous scan is to be reacquired from the subject)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the dental modeling features features of Paley in the modeling and imaging system of Rubbert, in order to provide improved guidance and visual feedback systems for use with particular three-dimensional imaging applications, such as digital dentistry (Paley, ¶9)

Kriveshko teaches:

wherein the at least the physical portion of the first virtual model replaced in the modifying step corresponds to the identified at least the physical portion. (¶11 the method may enter a landing mode which may include superimposing a current two-dimensional image of the subject onto a previous two-dimensional image of the subject in the display, the current two-dimensional image representing a view of the subject from a position from which the image set was acquired, and the previous two-dimensional image representing a view of the subject from which at least a portion of the three-dimensional surface data was acquired; acquiring at least one subsequent three-dimensional image; fitting the at least one subsequent three-dimensional image to a second three-dimensional surface reconstruction; and test fitting the at least one subsequent three-dimensional image to the three-dimensional surface data. When the image set can be fitted to the three-dimensional surface data, the method superimposes the three-dimensional surface data and the next three-dimensional image onto a two-dimensional image of the subject in a display and adds the second three-dimensional surface reconstruction to the three-dimensional surface data.)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the landing mode of Kriveshko when implementing the system of Rubbert as modified by Paley,

because Paley explicitly discloses a landing mode, and notes that the landing mode disclosed in Kriveshko is how this should be implemented (Paley, ¶60).

Regarding Claims 8 and 18:

Rubbert does not teach in particular:

causing the computer system to at least one of delete, remove or replace the identified portion of the first virtual model by applying a corresponding function to the first display image portion via interaction with the first display image on the display, to provide a modified first 3D virtual model;

obtaining the second virtual model in the form of a second 3D virtual model representative of a second physical portion of the teeth,

wherein a spatial disposition of the second physical portion with respect to the first physical portion is known or determinable;

virtually registering the second 3D virtual model with respect to the modified first 3D virtual model to provide the modified virtual model

wherein the identified portion of the first virtual model is replaced with the corresponding portion of said second 3D virtual model representative of a second physical portion; and

outputting the modified virtual model from the computer system.

Paley teaches:

obtaining the second virtual model in the form of a second 3D virtual model representative of a second physical portion of the teeth, (¶38 In a related landing mode, a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model. Similar visual feedback tools may be provided to guide a user to an appropriate scan location, and notify a user when the scan has been reacquired; ¶60 may permit a user to select a specific point on the surface of the digital model (or

the scan subject, although the distinction becomes trivial for highly detailed and accurate digital models) where the continuous scan is to be reacquired from the subject)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the dental modeling features features of Paley in the modeling and imaging system of Rubbert, in order to provide improved guidance and visual feedback systems for use with particular three-dimensional imaging applications, such as digital dentistry (Paley, ¶9)

Kriveshko teaches:

causing the computer system to at least one of delete, remove or replace the identified portion of the first virtual model by applying a corresponding function to the first display image portion via interaction with the first display image on the display, to provide a modified first 3D virtual model; (¶59 a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model; ¶70 any suitable technique for registering new three-dimensional data to existing three-dimensional data may be usefully employed in step 216; ¶74 all of the three-dimensional data acquired during the recover mode may be immediately registered to the original three-dimensional model; ¶83-85; ¶86 When a successful test fit is made to the original (acquisition mode) three-dimensional model, the entire new three-dimensional model, or a selected portion thereof, may be registered to the original three-dimensional model using a transformation based upon the successfully fitted frames or three-dimensional images; see also Rubbert ¶297-300 and 307.)

wherein a spatial disposition of the second physical portion with respect to the first physical portion is known or determinable; (¶11 the method may enter a landing mode which may include superimposing a current two-dimensional image of the subject onto a previous two-dimensional image of the subject in the display, the current two-dimensional image representing a view of the subject from a position from which the image set was acquired, and the previous two-dimensional image representing a view of the subject from which at least a portion of the three-dimensional surface data

was acquired; acquiring at least one subsequent three-dimensional image; fitting the at least one subsequent three-dimensional image to a second three-dimensional surface reconstruction; and test fitting the at least one subsequent three-dimensional image to the three-dimensional surface data. When the image set can be fitted to the three-dimensional surface data, the method superimposes the three-dimensional surface data and the next three-dimensional image onto a two-dimensional image of the subject in a display and adds the second three-dimensional surface reconstruction to the three-dimensional surface data.)

virtually registering the second 3D virtual model with respect to the modified first 3D virtual model to provide the modified virtual model (¶11 the method may enter a landing mode which may include superimposing a current two-dimensional image of the subject onto a previous two-dimensional image of the subject in the display, the current two-dimensional image representing a view of the subject from a position from which the image set was acquired, and the previous two-dimensional image representing a view of the subject from which at least a portion of the three-dimensional surface data was acquired; acquiring at least one subsequent three-dimensional image; fitting the at least one subsequent three-dimensional image to a second three-dimensional surface reconstruction; and test fitting the at least one subsequent three-dimensional image to the three-dimensional surface data. When the image set can be fitted to the three-dimensional surface data, the method superimposes the three-dimensional surface data and the next three-dimensional image onto a two-dimensional image of the subject in a display and adds the second three-dimensional surface reconstruction to the three-dimensional surface data.)

wherein the identified portion of the first virtual model is replaced with the corresponding portion of said second 3D virtual model representative of a second physical portion; and (¶11 the method may enter a landing mode which may include superimposing a current two-dimensional image of the subject onto a previous two-dimensional image of the subject in the display, the current two-

dimensional image representing a view of the subject from a position from which the image set was acquired, and the previous two-dimensional image representing a view of the subject from which at least a portion of the three-dimensional surface data was acquired; acquiring at least one subsequent three-dimensional image; fitting the at least one subsequent three-dimensional image to a second three-dimensional surface reconstruction; and test fitting the at least one subsequent three-dimensional image to the three-dimensional surface data. When the image set can be fitted to the three-dimensional surface data, the method superimposes the three-dimensional surface data and the next three-dimensional image onto a two-dimensional image of the subject in a display and adds the second three-dimensional surface reconstruction to the three-dimensional surface data.)

outputting the modified virtual model from the computer system. (¶11 superimposes the three-dimensional surface data and the next three-dimensional image onto a two-dimensional image of the subject in a display and adds the second three-dimensional surface reconstruction to the three-dimensional surface data.)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the landing mode of Kriveshko when implementing the system of Rubbert as modified by Paley, because Paley explicitly discloses a landing mode, and notes that the landing mode disclosed in Kriveshko is how this should be implemented (Paley, ¶60).

Regarding Claims 9 and 19:

Rubbert teaches:

wherein the first virtual model represents the first physical portion of the teeth, (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert

each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that as described, the frames would fall within the broadest reasonable interpretation of models.)

wherein the first virtual model is considered to fail to comply with a predetermined requirement, (Examiner notes that "failing to comply" would, under the broadest reasonable interpretation, include a model (e.g. frame of the reference) that did not have image/point cloud data for a portion, when an upcoming frame would. This would then include the frames progressively taken over each area of the object by the reference, e.g. ¶226 The frames are obtained at a rate of at least one frame per second as the scanner is moved over the teeth. The scanning of an entire jaw may require three separate scanning operations or “segments” due to maneuverability constraints and a break in the capturing of images. While the scanning is occurring, the four steps of FIG. 6 are performed for the stream of captured images; Examiner notes that this would also appear to include the following features: ¶298 The convergence factor 0.10 refers to the minimum amount of improvement needed between successive frames before a stationary count commences. The convergence factor is computed by taking the difference of the squares in the quality index of the ith iteration and the i−1 th iteration and dividing by the square of the quality index of the ith iteration; ¶300 The maximum iteration count value is a stop value to keep the process from running into an endless loop. The overlap size value is a limit, in terms of mm2, of the size where registration is performed. This serves to screen out stray points

from the registration algorithm. The minimum quota of active points is a minimum amount of overlap between two frames before registration will be attempted, expressed as a fraction of 1.)

wherein the predetermined requirement comprises providing high surface definition of a surface of interest in the first physical portion of the teeth. (¶301 he left hand side of FIG. 55 shows the results of each iteration, including the running time, the number of the iteration, the number of overlapping points, the overlap between frames (U), expressed as a fraction of 1, the quality index MA, and the value of the filter R. After 3 iterations, the quality index for coarse registration was met. The process continued with the fine registration. A series of fine registration iterations were performed. Note that the quality index MA improves with each registration iteration; examiner notes the quality index and overlap features appear to fall within the claim language here - the overlap fraction giving an indication falling within "high surface definition", absent further definition of that term in the claims.)

Regarding Claims 10 and 20:

Rubbert teaches:

wherein at least a part of the surface in the first physical portion was obscured by soft tissue or materials when the first 3D virtual model was created, and (¶304 When scanning any object, such as teeth, the situation may arise in which the operator of the scanning cannot capture all the surfaces of the object in one scanning pass. The interruption may be due to the need to physically move the scanner to a location that is impossible to reach from one location, the need for the patient to take a break from the scanning, or some other reason. When scanning teeth of a single jaw, the scanning is typically performed in two or three different segments. First, one side of the jaw is scanned, then the front of the jaw, and then the other side of the jaw. In this situation, there are three different segments of the object. All the frames of each segment are registered to each other, typically using a frame to frame registration. Then the segments are registered to each other. After this has been done, a cumulative

registration is performed of the entire jaw; examiner notes that "obscured" would include an impossible to reach location, as this would be blocked by materials of some form.)

wherein the second physical portion of the second physical part corresponds to the first physical portion of the first physical part wherein the at least the part of the surface of the first physical portion is now unobscured by soft tissue or materials. (¶304 When scanning any object, such as teeth, the situation may arise in which the operator of the scanning cannot capture all the surfaces of the object in one scanning pass. The interruption may be due to the need to physically move the scanner to a location that is impossible to reach from one location, the need for the patient to take a break from the scanning, or some other reason. When scanning teeth of a single jaw, the scanning is typically performed in two or three different segments. First, one side of the jaw is scanned, then the front of the jaw, and then the other side of the jaw. In this situation, there are three different segments of the object. All the frames of each segment are registered to each other, typically using a frame to frame registration. Then the segments are registered to each other. After this has been done, a cumulative registration is performed of the entire jaw; examiner notes that "unobscured" would include an impossible to reach location that is now possible to reach due to physically moving the scanner to a different location)

Regarding Claim 21:

Rubbert teaches:

an intraoral scanner; and (¶118 The scanning system 12 includes a scanner 14 which is used for image capture, and a processing system, which in the illustrated example consists of the main memory 42 and central processing unit 44 of the scanning node or workstation 16; ¶132 FIG. 4 is an illustration of a patient 70 being scanned with the hand-held scanner 14 of FIG. 3. The checks and lips are retracted

from the teeth and the tip 68 of the scanner is moved over all the surfaces of the teeth in a sweeping motion at a velocity of perhaps 1-2 centimeters per second.)

a non-transitory computer readable medium including instructions that when executed by a computer system, causes the computer system to: (¶118 The scanning system 12 includes a scanner 14 which is used for image capture, and a processing system, which in the illustrated example consists of the main memory 42 and central processing unit 44 of the scanning node or workstation 16.)

"display an image of a first virtual model on a display, (¶128 The scanning work station 16 also includes the monitor 20 for displaying the scanning results as a three-dimensional model 18 of the dentition in real time as the scanning is occurring; ¶226 The frames are obtained at a rate of at least one frame per second as the scanner is moved over the teeth. The scanning of an entire jaw may require three separate scanning operations or “segments” due to maneuverability constraints and a break in the capturing of images. While the scanning is occurring, the four steps of FIG. 6 are performed for the stream of captured images; examiner notes that this illustrates that the mdoel is updated as the scanning occurs, and that it is displayed in real time showing the updates.

¶229 The result, step 86 of FIG. 6, is a set of three dimensional coordinates for all the points in the image, a point cloud comprising a “frame.” FIG. 29 is an illustration of a single “frame” of data, that is, a three-dimensional point cloud of a scanned object which has been calculated from a single two dimensional image by the pattern recognition, decoding, and 3-D calculations described herein; ¶230 Commercially available off-the-shelf software exists for taking a set of three dimensional coordinates and displaying them on a computer monitor, and such software is used to display the three dimensional surfaces; examiner notes that this illustrates the frames themselves (which fall within the term models) are also displayed.)"

wherein the first virtual model is generated from first 3D scan data of the teeth, and (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken

from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that as described, the frames would fall within the broadest reasonable interpretation of models.)

wherein the first virtual model includes a portion that is a deficient representation of a first physical portion of the teeth; (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that substantial overlap is present, but that the at least two frames of the reference are each incomplete regarding the object being modelled, thereby each failing to represent some part of the object)

thereby generating the modified virtual model; and (¶24; ¶28 processing said data representing the set of frames with the data processing system so as to register the frames relative to each other to thereby produce a three-dimensional virtual representation of the portion of the surface of the object covered by the set of frames ... the three-dimensional virtual representation being substantially consistent with all of the frames.)

wherein the portion of the first virtual model is of the first physical portion of the teeth, and the corresponding portion of the second virtual model is also of the first physical portion of the teeth. (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that as described, the frames would fall within the broadest reasonable interpretation of models.)

Rubbert does not teach in particular:

receiving an identification of the portion of the first virtual model that is the deficient representation of the first physical portion of the teeth;

obtain a second virtual model of the teeth with the computer system,

the second virtual model generated from second 3D scan data of the teeth; and

modify the first virtual model with the computer system by replacing at least the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth with a corresponding portion of the second virtual model that provides an adequate representation of the first physical portion,

Paley teaches:

receiving an identification of the portion of the first virtual model that is the deficient representation of the first physical portion of the teeth; (¶60 One user control (not shown) may permit a user to return to data acquisition, e.g., the scanning mode of FIG. 4, to acquire additional data where a void or deviation is detected (either automatically or through human visual inspection). This control, or another control, may permit a user to select a specific point on the surface of the digital model (or the scan subject, although the distinction becomes trivial for highly detailed and accurate digital models) where the continuous scan is to be reacquired from the subject)

obtain a second virtual model of the teeth with the computer system, (¶38 In a related landing mode, a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model. Similar visual feedback tools may be provided to guide a user to an appropriate scan location, and notify a user when the scan has been reacquired; ¶60 may permit a user to select a specific point on the surface of the digital model (or the scan subject, although the distinction becomes trivial for highly detailed and accurate digital models) where the continuous scan is to be reacquired from the subject)

the second virtual model generated from second 3D scan data of the teeth; and (¶28 the system 100 may include a scanner 102 that captures images of a subject 104 within an image plane 106, and forwards the images to a computer 108, which may include a display 110)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the dental modeling features features of Paley in the modeling and imaging system of Rubbert, in

order to provide improved guidance and visual feedback systems for use with particular three-dimensional imaging applications, such as digital dentistry (Paley, ¶9)

Kriveshko teaches:

modify the first virtual model with the computer system by replacing at least the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth with a corresponding portion of the second virtual model that provides an adequate representation of the first physical portion, (¶59 a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model; ¶70 any suitable technique for registering new three-dimensional data to existing three-dimensional data may be usefully employed in step 216; ¶74 all of the three-dimensional data acquired during the recover mode may be immediately registered to the original three-dimensional model; ¶83-85; ¶86 When a successful test fit is made to the original (acquisition mode) three-dimensional model, the entire new three-dimensional model, or a selected portion thereof, may be registered to the original three-dimensional model using a transformation based upon the successfully fitted frames or three-dimensional images; see also ¶28, 298, 299, and 300 of Rubbert)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the landing mode of Kriveshko when implementing the system of Rubbert as modified by Paley, because Paley explicitly discloses a landing mode, and notes that the landing mode disclosed in Kriveshko is how this should be implemented (Paley, ¶60).

Regarding Claim 22:

Rubbert teaches:

cause the system to receive user input identifying on the image of the first virtual model at least the portion of the first virtual model, (¶305 Therefore, the segment registration proceeds by the user

selecting or indicating a point on the canine teeth to use for performing segment registration. A procedure referred to herein as "landmarking" is used to select the point used to register segments; ¶307 FIG. 57 is a screen shot showing a graphical representation of a three-dimensional model of a patient's upper front teeth (segment 1) after a frame to frame registration of this segment. The user is applying landmarks to the canine teeth as a preliminary step in treatment planning, and as a step in registering overlapping segments of a scanned upper jaw relative to each other to calculate a complete model of the upper jaw and associated dentition;)

wherein the portion includes the portion of the first virtual model that is the deficient representation of the first physical portion of the physical teeth, and (¶307 FIG. 57 is a screen shot showing a graphical representation of a three-dimensional model of a patient's upper front teeth (segment 1) after a frame to frame registration of this segment. The user is applying landmarks to the canine teeth as a preliminary step in treatment planning, and as a step in registering overlapping segments of a scanned upper jaw relative to each other to calculate a complete model of the upper jaw and associated dentition; ¶310 The overlapping frames between each segment can be registered to each other, or to the entire other segment.)

wherein the portion of the first virtual model replaced in the modifying step corresponds to the identified physical portion. (¶28 processing said data representing the set of frames with the data processing system so as to register the frames relative to each other to thereby produce a three-dimensional virtual representation of the portion of the surface of the object covered by the set of frames ... the three-dimensional virtual representation being substantially consistent with all of the frames; ¶311 After segment registration is performed, a cumulative registration of the entire jaw is performed in accordance with the procedure of FIG. 48. After the cumulative registration is performed, the virtual three-dimensional model of the entire jaw is presented to the orthodontist on the monitor in the back office server workstation 28.)

Regarding Claim 24:

Rubbert teaches:

removing the portion of the first virtual model that is the deficient representation of the first physical portion of the physical teeth; (¶324-326; ¶326, The planes serve as boundaries for the selection of tooth scan data as an individual virtual tooth object, or as part of the iterative procedure of FIG. 58. All 3-D data that is outside of the planes 1000 and 1002 is ignored.)

Rubbert teaches details of registration, but Kriveshko teaches the following features in more explicit detail:

registering the second virtual model with the first virtual model; and

stitching the corresponding portion of the second virtual model that provides an adequate representation of the physical portion into the first virtual model, thereby creating a modified first virtual model.

Kriveshko teaches:

registering the second virtual model with the first virtual model; and (¶59 a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model; ¶70 any suitable technique for registering new three-dimensional data to existing three-dimensional data may be usefully employed in step 216; ¶74 all of the three-dimensional data acquired during the recover mode may be immediately registered to the original three-dimensional model; ¶86 the entire new three-dimensional model, or a selected portion thereof, may be registered to the original three-dimensional model using a transformation based upon the successfully fitted frames or three-dimensional images.)

stitching the corresponding portion of the second virtual model that provides an adequate representation of the physical portion into the first virtual model, thereby creating a modified first virtual model. (¶66 the incremental three-dimensional image data may be fitted or stitched to the

existing three-dimensional model. In one embodiment, this process is performed by deriving scanner motion between positions or points of view for successive image captures; ¶74 In the stitch recover mode 226 the process 200 may attempt to reacquire or resume a scan by test fitting each newly acquired data set to some portion of the three-dimensional model. During this phase, the process may optionally begin assembling a new three-dimensional model from sequential, incremental three-dimensional data sets. In this manner, once the original scan is reacquired with a successful fit to the original three-dimensional model, all of the three-dimensional data acquired during the recover mode may be immediately registered to the original three-dimensional model.)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the landing mode of Kriveshko when implementing the system of Rubbert as modified by Paley, because Paley explicitly discloses a landing mode, and notes that the landing mode disclosed in Kriveshko is how this should be implemented (Paley, ¶60).

Regarding Claim 25:

Rubbert does not teach in particular:

wherein the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth, includes a representation of the first physical portion of the teeth before a material removal procedure and

the corresponding portion of the second virtual model that provides an adequate representation of the first physical portion of the teeth includes a representation of the first physical portion after the material removal procedure.

Paley teaches:

wherein the identified portion of the first virtual model that is a deficient representation of the first physical portion of the teeth, includes a representation of the first physical portion of the teeth

before a material removal procedure and (¶67 can be tested for against an accurate three-dimensional representation of an actual surface preparation, with suitable visualizations generated to guide a dentist in improving or accepting a preparation.)

the corresponding portion of the second virtual model that provides an adequate representation of the first physical portion of the teeth includes a representation of the first physical portion after the material removal procedure. (¶65 In an iterative process, a dentist may repeat steps of tooth removal and scanning until a satisfactory surface preparation is achieved.)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the dental modeling features features of Paley in the modeling and imaging system of Rubbert, in order to provide improved guidance and visual feedback systems for use with particular three-dimensional imaging applications, such as digital dentistry (Paley, ¶9)

Regarding Claim 26:

Rubbert teaches:

the obtaining, by the intraoral scanner, the second virtual model of the teeth with the computer system, includes: receiving second 3D intraoral scan data of the teeth comprising scan data of the first physical portion of the teeth and scan data of a second physical portion of the teeth, the second physical portion being adjacent the first physical portion, and (¶22 During scanning, the scanner and object are moved relative to each other resulting in each image being taken from a different position relative to the surface of the object. The method continues with a step of processing the data representing the set of images with the data processing system so as to convert each of the two-dimensional images into a data representing a frame. The frame is essentially a cloud of individual points, each point in each frame is expressed as a location in a three-dimensional coordinate system. Thus, the set of images are processed to thereby generate a set of frames corresponding to the set of images; ¶26 obtaining a set of

at least two digital three-dimensional frames of portions of the object, wherein the at least two frames comprise a set of point coordinates in a three dimensional coordinate system providing differing information of the surface of the object, wherein those frames provide a substantial overlap of the represented portions of the surface of the the object; examiner notes that as described, the frames would fall within the broadest reasonable interpretation of models, and that at least two are set forth)

Rubbert does not teach in particular:

wherein the scan data of the second physical portion is used to align the second virtual model of the teeth with the first virtual model before the modifying, by the computer system, the first virtual model by replacing at least the identified portion of the first virtual model.

Kriveshko teaches:

wherein the scan data of the second physical portion is used to align the second virtual model of the teeth with the first virtual model before the modifying, by the computer system, the first virtual model by replacing at least the identified portion of the first virtual model. (¶11 the method may enter a landing mode which may include superimposing a current two-dimensional image of the subject onto a previous two-dimensional image of the subject in the display, the current two-dimensional image representing a view of the subject from a position from which the image set was acquired, and the previous two-dimensional image representing a view of the subject from which at least a portion of the three-dimensional surface data was acquired; acquiring at least one subsequent three-dimensional image; fitting the at least one subsequent three-dimensional image to a second three-dimensional surface reconstruction; and test fitting the at least one subsequent three-dimensional image to the three-dimensional surface data. When the image set can be fitted to the three-dimensional surface data, the method superimposes the three-dimensional surface data and the next three-dimensional image onto a two-dimensional image of the subject in a display and adds the second three-dimensional surface reconstruction to the three-dimensional surface data.; see also ¶24 and ¶28 of Rubbert)

It would have been obvious to one of ordinary skill in the art at the time the invention was filed to use the landing mode of Kriveshko when implementing the system of Rubbert as modified by Paley, because Paley explicitly discloses a landing mode, and notes that the landing mode disclosed in Kriveshko is how this should be implemented (Paley, ¶60).

Claim 23 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Rubbert (US 2002/0006217A1) in view of Paley (US 2007/0172112 A1) and Kriveshko (US 2007/0236494 A1), and further in view of Babayoff (US 2005/0283065A1).

Regarding Claim 23:

Rubbert does not teach in particular:

the portion of the first virtual model that is the deficient representation of the first physical portion of the physical teeth includes a finish line of the first virtual model; the portion of the second virtual model that is the adequate representation of the first physical portion of the physical teeth includes a finish line of the second virtual model; and the physical portion of the teeth includes a finish line of a prepared tooth.

Babayoff teaches:

the portion of the first virtual model that is the deficient representation of the first physical portion of the physical teeth includes a finish line of the first virtual model; the portion of the second virtual model that is the adequate representation of the first physical portion of the physical teeth includes a finish line of the second virtual model; and the physical portion of the teeth includes a finish line of a prepared tooth. (examiner notes that when the finish line detection and definition methods of Babayoff are applied to the image registration system of Rubbert, the finish line would be subject to the registration procedures - the data set being separated into entities being applied as frames being registered to each other, resulting in a system that registers the finish line information from the "specific

data entity" (as discussed in ¶174) to the remaining frames/data entities that do not have such data (the other entities from ¶174); ¶104 Any suitable means may be used to provide the numerical entity. For example, a three-dimensional surface scanner with color capabilities may be used; ¶172 may also be applied to the identification of a finish line profile for a crown or bridge prosthesis; ¶174 The ring thus adopts a profile which may often be substantially similar to that of the finish line. By having the ring colored sufficiently differently to the color of the teeth or soft tissues, say in blue, it is relatively straightforward to separate out from the entity I all data points having a color component with a value in a specific range corresponding to the color of the ring. Identification of the ring itself provides a useful starting point for suitable algorithms that are then applied to determine the location and geometry of the finish line. Such algorithms are known and typically attempt to identify features commonly found with finish lines such as for example, a discontinuity in the slope of the tooth surface, or a mound-shaped projection corresponding to the preparation ... In particular, when the data set has been separated into entities I.sub.1, then only the specific entity I.sub.1 corresponding to the ring needs to the analysed for the finish line, as this entity corresponds to the preparation; see also ¶182-186 which discusses "automatically defining the finish line of a preparation.")

It would have been obvious to one having ordinary skill in the art at the time the invention was filed to apply the finish line modeling and identification of Babayoff to the image registration of Rubbert as modified by Paley and Kriveshko, in order to provide data that is useful in procedures associated with the oral cavity, specially dental surfaces thereof (Babayoff ¶1).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to BIJAN MAPAR whose telephone number is (571)270-3674. The examiner can normally be reached on Monday - Thursday, 11:00-8:30.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Omar F Fernandez Rivas can be reached on 5712722589. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/BIJAN MAPAR/
Examiner, Art Unit 2128